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The very great obliquity of the orbit affects the accuracy of the determination of the inclination, the angle in the numerator of the expression,

$$\cos i = \frac{\sin (\varphi - \varphi')}{\sin (v' - v) \cdot \sec \lambda \cdot \sec \lambda'}$$

being only 4° 19′ 13″, using the interval from the 8th to the 27th.

"It may be remarked that Pontécoulant's modification of La Place's method of approximating to the two fundamental elements gives an error of about —·0056 in the perihelion distance, and one of about —·0078 days, or —11 minutes, in the time of perihelion passage.

"*June 5th,* 1854."

Observations on an important Phenomenon observed with regard to the Hill of Santa Lucia, situated in the City of Santiago de Chile. By Don Carlos Moesta.

"The summit of the hill of Santa Lucia, situated in the capital of the Republic of Chili, is 630 mètres above the level of the sea, and about 60 above the city. Its greatest base is from N. to S., measuring some 5 cuadras (the cuadra is 150 varas square); its perpendicular line scarcely 2 cuadras.

"The rock of the hill, at first sight, appears to be a basalt; but, on examination, Señor Domeyko has determined it to be a variety of metamorphic porphyry, which he calls 'porfido abijarrado.' The columns of the rock have in various parts not only different directions, but various inclinations. However, the columns in the most southern part of the hill run W. 60° N. with an inclination of 36° to S.E.; the columns at the N. are nearly horizontal, with direction to W. a little to N. The upper part of the hill N.E. and S. is covered with a layer of earth, and not much vegetation; part of it also has broken stones (angular); but to the W., where there is a quarry, the heads of the columns are seen, and it is here where the hill is very steep. It has been necessary to enter into the above details to better understand the phenomenon I am about to refer to.

"In the N. part of the hill was erected, in 1849, the Astronomical Observatory, and it was then believed this was the most favourable position. I here only allude to the house which contains the transit instrument. The axis of the instrument rests on two blocks of stone of 6½ feet, which are placed in solid masonry upon the firm rock, without touching any broken or soft parts of the rock.

"The rock that serves as foundation to this masonry, as I have already stated, is of the before-mentioned columns of porphyry; the direction of these is about in a line with the axis of the instrument, and with but little inclination. In the construction of the instrument, as well as in the fixing it, the greatest care

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was taken, so as to compensate for all exterior influences of variation of temperature, pressure of the air, &c.

" Independently of all this, Mr. Gilliss* has observed from the period of the erection of the observatory, that the end of the axis to the E. was constantly elevating itself, and that it was found necessary to lower this end from time to time, so that the instrument might be maintained in the most convenient position for observing. This phenomenon has been observed since then until the present time, and clearly shows that the block on which rests the extremity of the axis to the east is being raised above the surface of the earth, and in such a manner, that if we add the small quantities, the other end has been lowered since the erection of the observatory in 1849 (these observations of Moesta's were made in March 1853), the difference will be *a quarter of an inch.*

" So interesting a phenomenon induced me to examine if this elevation was effected suddenly, that is to say, by movements caused by earthquakes, which are scarcely sensible on the surface of the earth, or by a motion slow but gradual.

" I proposed to level the instrument every 12 hours, with all possible exactitude; and in carrying on these operations, I observed another phenomenon, not less interesting than the first. I observed that in taking these levels, with the large level of the transit, the position of the axis was subject to oscillations dependent on temperature.

" Here are the observations I refer to:—

Days.	Height of Axis to the East.	Height of Axis to West.	Error of Obs.	Prob. Error of Result.	Temperature, Fahr.	State of Atmosphere.	
1853.					°		
Mar. 4	0·007	...	0·190	0·064	70·7	Clear and calm.	
5	...	1·049	0·246	0·058	91·6	—	—
	0·063	...	0·037	0·009	70·0	—	—
8	...	1·794	0·074	0·022	84·0	—	South wind.
	...	1·052	0·206	0·069	62·5	—	Calm.
9	...	2·227	0·067	0·023	89·0	—	—
	...	1·210	0·121	0·040	69·7	—	—
11	...	2·431	0·220	0·065	88·5	Cloudy	—
	...	1·803	0·240	0·064	68·0	Clear	—
12	...	2·369	0·204	0·061	84·5	Cloudy;	strong S. wind.
14	...	2·695	0·050	0·016	68·0	—	Calm.
	...	2·475	0·029	0·009	62·5	—	—
15	...	3·041	0·151	0·045	77·5	Clear	—

" This table contains, independently of the difference of elevation of the two extremities of the axis, the temperature and state of the atmosphere; and so that we may have an idea of the exactitude of the observations, I have calculated the medium errors of the observations, as well as the probable. Observe that the observations are made at intervals of 12 hours. It is sufficient to look at the table to be convinced that the end of the axis to the E. rises and falls with elevation or depression of temperature; and as, by the construction of the instrument, the temperature influences both ends of the axis in a similar manner, we have to look for the cause of that oscillation away from the instrument; *this cause can be no other than the expansion and contraction of the columns of porphyry*, in which is placed the block that supports the west extremity of the axis; expansion and contraction caused by the heat of the sun during the day and the cold at night.

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* Chief of the United States Astronomical Expedition.

"Thus, for example, on the 4th and 5th March, the axis rose to the west,

1″·056

whilst the temperature rose

70°·7 to 91°·6 F.

"The same axis fell afterwards

1″·112

"Temperature depressed

91°·6 to 70° F.

"Little more or less we find this same result in the second group of observations; and if the difference of level in these two groups have not the same relation, with the corresponding differences of temperature, less have we of coincidence in the following group. The 11th and 12th of March the difference of level was only

	0″·628
Temperature depressed from	88°·5 to 61° F.
And it is	0″·596
Temperature rising	68° to 84°·5 F.

"But this inequality of the differences of level for equal differences of temperature is a proof most truly, that the expansion of the rock produced by the sun's heat is the cause of the rising of the hill.

"The first two groups of observations show that the difference of level was a little more or less than

1″

the difference of temperature rising, medium height, to 20°; whilst in the third group the difference of level is only

0″·628,

notwithstanding the difference of temperature was the same.

"But the last column of the table indicates that at the same time, during the first observations, the sky was clear, and cloudy during the others. It is evident that, with a clouded sky, the hill or rock cannot become so heated as when it receives the direct rays of the sun; and, consequently, the difference of the temperature of the air and that of the rock must be less in the first case than in the second.

"The temperature of the rock will also depend upon the wind; for example, it will be less when blowing strong from S., or when it is calm. Supposing in both cases the temperature of the air to be the same. Thus, then, there cannot be a constant relation between the differences of level and the difference of temperatures; but it is more than probable that we shall find determined the differences of the temperature of the same rock, in place of the temperature of the air.

"The last group of the observations presents an example in which the level, during 12 hours, remains constant: this fact coincides with the very small change of temperature; in effect, the temperature for the difference being (on the 14th) only $5^{\circ}\cdot 5$; the difference of level was not above

$0''\cdot 22$

"According to these obserrvations, there cannot be a doubt that the heat of the sun is the cause of the phenomenon in question; and now it only remains to inquire, how comes it that there is only a partial rising of that part of the hill situated to the west, which elevation is indicated by the level.

"To resolve this question, we must again revert to the topography and geology of the Hill of Santa Lucia.

"I have said that in the W. part of the hill the porphyritic columns are exposed to the immediate influence of the sun, whilst in other parts the hill is covered with a layer of vegetation and broken rock, which protects the said columns from the sun's heat. Moreover, these columns have a N.W. direction, with a strong inclination to the west; so that being exposed from 12 P.M. to the evening to the sun's rays, which fall almost perpendicularly upon the heads of the columns, will necessarily suffer a greater expansion than the great body of the hill situated to the N. and E., which is shaded.

"And thus we must be struck with this wonderful power or force of the sun which causes to rise and fall *periodically* this enormous mass of firm and hard rock analogous to that other force which causes to rise and fall *periodically* the column of mercury in the barometer.

"It will now easily be conceived that in the vicinity of Santiago there could not be a worse place for an observatory than the Hill of Santa Lucia, it being of the greatest importance to have such established at a point where the atmospheric influences have the least possible effect on the instruments."